

Advanced Curation Activities at NASA: Preparing to Receive, Process, and Distribute Samples Returned from Future Missions

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Introduction: The Astromaterials Acquisition and Curation Office (henceforth referred to herein as NASA Curation Office) at NASA Johnson Space Center (JSC) is responsible for curating all of NASA's extraterrestrial samples. Under the governing document, NASA Policy Directive (NPD) 7100.10F JSC is charged with curation of all extraterrestrial material under NASA control, including future NASA missions. The Directive goes on to define Curation as including documentation, preservation, preparation, and distribution of samples for research, education, and public outreach. Here we briefly describe NASA's astromaterials collections and our ongoing efforts related to enhancing the utility of our current collections as well as our efforts to prepare for future sample return missions. We collectively refer to these efforts as advanced curation.

NASA Curation: The NASA Curation Office presently curates nine different astromaterials collections: (1) Apollo samples, (2) Luna samples (Soviet Union), (3) Antarctic meteorites, (4) Cosmic dust particles, (5) Microparticle Impact Collection [formerly called Space Exposed Hardware], (6) Genesis solar wind atoms, (7) Stardust comet Wild-2 particles, (8) Stardust interstellar particles, and (9) Hayabusa asteroid Itokawa particles (JAXA).

In addition, the next missions bringing samples back to Earth are Hayabusa 2/ asteroid Ryugu (JAXA) and OSIRIS-Rex/ asteroid Bennu (NASA), in 2021 and 2023, respectively. We currently house contamination knowledge (CK) witness plates for OSIRIS-REx, and we will soon begin curating CK witness plates for the Mars 2020 mission, which is going to collect and cache martian samples for possible future return to Earth.

Advanced Curation at NASA: The NASA Curation Office plans for the requirements of future collections in an "Advanced Curation" program. Advanced Curation is tasked with conducting research to develop, invent, integrate, test, and evaluate new and innovative technologies for sample collection, contamination control, clean handling, characterization, analysis, and curation of astromaterials collected by human and non-human explorers – protecting the scientific integrity of each sample from the point of mission inception through long-term preservation and distribution on Earth. As each new sample collection is returned, new facilities are added to accommodate them.

Advanced Curation at NASA is founded as a cross-disciplinary field of advanced research and development under the auspices of the Astromaterials Acquisition and Curation Office at NASA Johnson Space Center. Advanced curation conducts research, explores and invents new innovative technologies and techniques for collection, handling, characterization, analysis, and curation of astromaterials that could be used in next generation human and robotic space exploration missions and current collections. Advanced Curation has a primary goal of expanding the sample processing and storage capabilities of NASA's astromaterials curation facilities to prepare for future sample return missions as well as maximizing the science returns of our existing sample collections. In addition, the program integrates, tests, and evaluates new technologies and operational procedures for future sample return missions through human and robotic analog studies. These goals are aimed at improving our core curation functions of protecting the scientific integrity of NASA's astromaterials collections and serving as responsible distributors of astromaterials to the global community of sample scientists and educators in a fair, timely, and professional manner. The primary result of advanced curation is to reduce contamination to astromaterials and preserve the scientific integrity of all samples from mission inception and through ATLO, sample collection, preliminary examination on Earth, curation, and secure delivery of the samples to Earth-based laboratories for in-depth scientific analyses.

Curation starts at the inception of a sample return mission, and Advanced Curation is an ever-evolving field with specific foci that start at the inception of a sample return concept. If we look only at improving upon our current curation capabilities, we will not be prepared when returned samples require care that is very different from those within our current collections. At present, most of the samples we curate are geologic in nature, with the exception of the Genesis solar wind atoms that are implanted within a number of inorganic substrates. All of the samples are kept close to room temperature, and we do not curate gases, liquids, ices, or biologic materials. However, future sample return missions may bring back samples that require storage and handling conditions outside of our current capability, so we must prepare for such instances. Additionally, many of our samples, when kept in the pristine environments of our labs, will maintain their fidelity indefinitely. Returned samples from future missions – ices, for example – may have certain properties that have a short "shelf-life", and hence curation will need to determine such shelf lives for particular types of analyses through analog studies so that we can prioritize the order in which science questions are answered from a particular collection. Another aspect of advanced curation is expanding our ability to document samples, analyses, and sample histories.

Concluding Remarks: The return of every extraterrestrial sample is a scientific investment, and the curation facilities and personnel are the primary managers of that investment. Our primary goals are to maintain the integrity of the samples and ensure that the samples are distributed for scientific study in a fair, timely, and responsible manner. It is only through the long-term stability and support of curation facilities, coupled with the infusion of technological advances realized through new advanced curation initiatives that the maximum returns on that scientific investment are achieved. In the coming decades, sample return missions will increase in their complexity with respect to sample storage and sample handling requirements. Our advanced curation efforts today ensure we will be poised to curate and handle these samples upon return.